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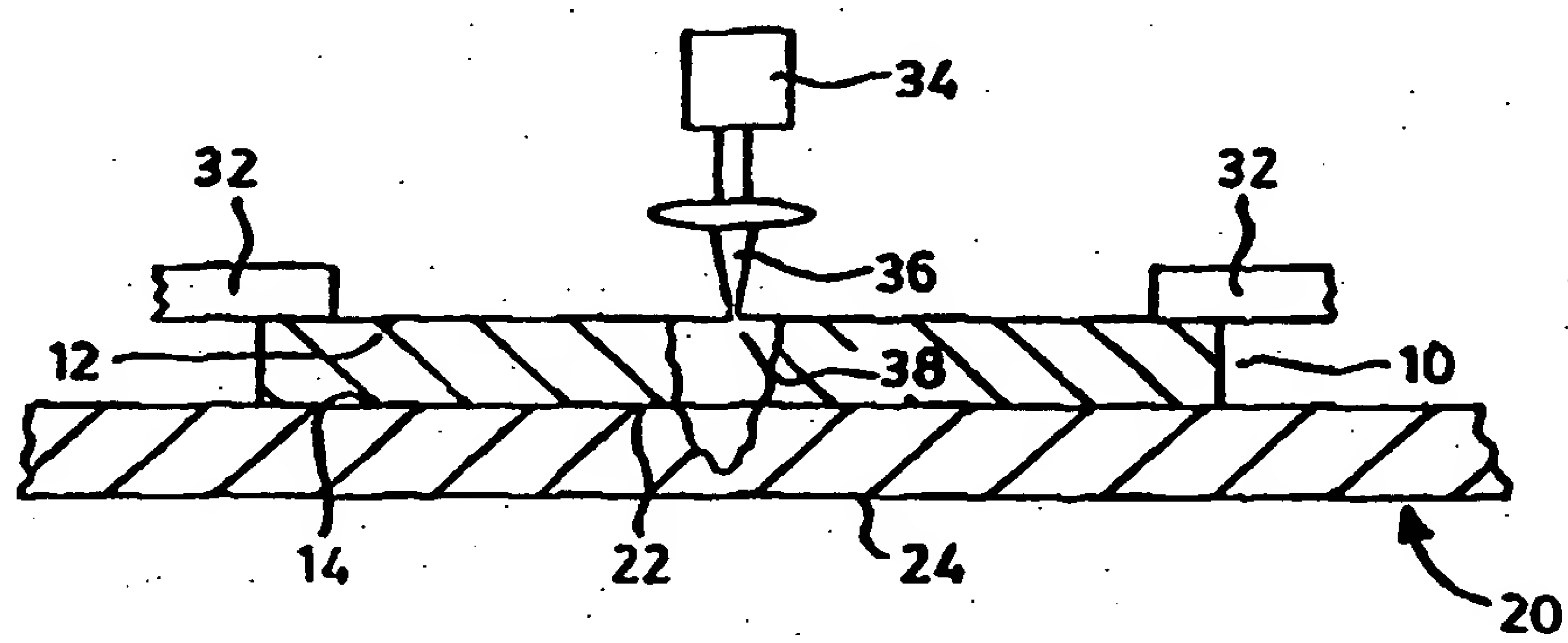
(54) Title: TAILORED BLANK

(57) Abstract

A tailored blank is provided by welding a pair of constituent parts (10, 20) to one another in juxtaposition. The parts (10, 20) are laser welded (34, 36, 38) together to form a unitary blank (42) that is subsequently formed into a shaped finished component.



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TAILORED BLANK

The present invention relates to a method of forming tailored blanks to be used to produce shaped metal components.

Sheet metal components of complex shapes are typically produced from a planar blank that is formed into the finished shape through a series of forming or stamping operations. Where relatively complex components are to be produced, it is usual to build the component out of a number of individual elements, each of which is stamped from a blank. The need to use multiple components may result from the complexity of the finished product or may result from the different characteristics of the material required in different areas of the component. For example, if the component is a door frame of an automobile, the majority of the door frame may be formed from a relatively thin metal sheet but the mounting points for the hinges of the door require extra strength. The use of multiple elements to produce the finished component increases the manufacturing complexity.

To mitigate this complexity, it has been proposed to produce a tailored blank in which appropriately shaped sheets of material are connected edge to edge by a laser welding process to produce a unitary blank. When formed, the blank produces a component with differing material characteristics through the structure. This process permits optimum use of the material but at the same time minimizes the subsequent assembly of multiple elements into the final component.

The production of a tailored blank requires the constituent sheet metal parts to be cut accurately so that the laser welding may be performed efficiently and retain an adequate weld quality. This requires precision cutting of the constituent components and in our co-pending Application Nos. 9624039.5 filed November 19, 1996 and 9624652.5 filed November 27, 1996 and an application entitled "Overlapping Joint for Laser Welding of Metals Including Tubes" filed January 8, 1997, various methods are described to mitigate the difficulties encountered with obtaining the required precision from the constituent parts. However, in certain circumstances, it is desirable to produce a formed component with a very high quality surface finish so that subsequent processing such as painting can be accomplished with a minimum of refurbishment of the surface after welding. While laser welding offers in general a relatively high-quality welded surface and the processes contemplated in the above-mentioned applications further facilitate the production of a smooth outer surface, there is nevertheless the need for a tailored blank that may be used directly to produce a

finished surface.

It is therefore an object of the present invention to obviate or mitigate the above disadvantages.

In general terms, the present invention provides a tailored blank having a pair of sheet metal constituent parts each having a pair of oppositely directed major surfaces. A major surface of one of the components is placed on the major surface of another of the components and the parts welded to one another to produce a unitary blank. The blank may then be subsequently formed into a component of varying material characteristics.

Preferably the welding of the constituent parts is performed by laser welding and as a further preference, the laser welding does not penetrate to the other major surface of the other constituent part.

Embodiments of the invention will now be described by way of example only, with reference to the accompanying drawings in which

Figure 1 is a sectional view of a pair of constituent parts prior to processing;

Figure 2 is a sectional view of the components after processing;

Figure 3 is a top perspective view of the components after processing;

Figure 4 is a schematic representation of a part formed from the components of Figure 3;

Figure 5 is an alternative embodiment of tailored blank;

Figure 6 is a further embodiment of a tailored blank;

Figure 7 is a sectional view of an alternative processing arrangement of a tailored blank;

Figure 8 is a sectional view showing the processing of tubular components;

Figure 9 is a perspective view of a finished component formed from the blank of Figure 8;

Figure 10 is a side view of a further embodiment of blank similar to Figure 9;

Figure 11 is a side view of a yet further embodiment similar to Figure 10;

Figure 12 is a section of an alternative arrangement of blank incorporating a supplementary component;

Figure 13 is a plan view of a blank used in the forming of an automobile component;

Figure 14 is a section on the line 14-14 of Figure 13;

Figure 15 is a section similar to Figure 14 showing a subsequent step in the forming;

Figure 16 is a sectional view of the finished component;

Figure 17 is a flow chart showing the sequence of steps performed in Figures 13-16;

Figure 18 is an exploded view of components of a further embodiment of blank;

Figure 19 is a side view of the assembled blank of Figure 18;

Figure 20 is a plan view of Figure 19;

Figure 21 is a section of a further embodiment of the blank shown in Figure 19; and

Figure 22 is a series of schematic representations of blanks formed using the embodiments of Figures 18-21.

Referring therefore to Figure 1, a pair of constituent parts 10,20 which may have differing characteristics - in this case differing thicknesses - are each planar and formed from weldable sheet metal. As such, each has a pair of oppositely directed major surfaces 12,14 and 22,24 interconnected at the periphery by edges 16,26 respectively.

The constituent parts 10,20 are positioned in juxtaposition with one major surface 14 of the constituent part 10 overlying and in abutment with one of the major surfaces 22 of the constituent part 20. The constituent part 10, which is of smaller area than that of the constituent part 20, is positioned within the periphery of part 20 such that after forming, an increased thickness of material will be available in the desired region of the finished component.

The constituent parts 10,20 are secured in abutting relationship by clamps 32 of suitable form including magnetic clamps if the components themselves are magnetic. A laser 34 directs a beam 36 onto the exposed major surface 12 of the constituent part 10 and produces local melting of the constituent part 10 and the major surface 22. The beam 36 is controlled so that partial penetration of the component 20 is obtained but the liquid region 38 does not extend to the lower surface 24. The irradiated area may be shielded with an inert gas in a conventional manner as appropriate.

The beam 36 is caused to translate relative to the constituent parts 10,12 along a predetermined path so that as the beam 36 moves, the constituent part 10 and part of the constituent part 20 melt locally in the region indicated by numeral 38. Continued movement of the beam 36 allows the region 38 of the constituent parts 10,20 to solidify after passage of the beam and be joined to one another as indicated by weld 40.

As indicated in Figure 3, the beam 36 is repositioned laterally to provide welds at spaced locations and thereby secure the one constituent part 10 to the other constituent part 20. Alternatively, multiple beams may be used to produce welds simultaneously.

After welding, the constituent parts 10,20 provide a unitary tailored blank 42 which may then be subsequently formed into a component of the required shape as shown schematically in Figure 4. A pair of complementary dies 44,46 engage opposite faces 12,24 of the blank 42 to form it into a shape defined by the dies. The components 10,20 are each formed resulting in a finished component of the desired complex shape.

By controlling the beam 36 such that melting only proceeds part way through the constituent part 20, the major surface 24 is not adversely affected by the welding process and therefore presents a continuous smooth surface that may not require additional processing prior to finishing. At the same time, the blank provides varying material characteristics in the finished component. It will be appreciated that full penetration of the constituent part 20 may be permitted where final surface finish is not significant.

In tests conducted with the composite blank 42 shown in Figure 3, the following parameters were utilized:

relative speed between laser beam and the constituent part:	6.2 metres per minute
laser beam power:	6 kilowatts utilizing a CO_2 continuous laser;
laser beam mode:	TEM_{01}
laser beam diameter:	0.028 inches
shield gas:	helium above, argon below;
thickness of constituent part 20:	$t^1 = 0.034$ inches;
thickness of constituent part 10:	$t^2 = 0.074$ inches;
constituent part material:	galvaneal (hot rolled galvanized mild steel)

Naturally the constituent parts may be similar to one another having the same thickness and composition or may be selected with different characteristics, such as thickness, composition, coating or the like. By selecting the constituent part 10 of the appropriate characteristics, the unitary blank 42 is formed with a uniform surface but with local

reinforcements to provide varying characteristics in the formed component. In one particularly beneficial embodiment, the constituent part 20 is zinc coated and the constituent part 10 is cold rolled steel. The surface 24 of the part 20 is thus not affected by welding to provide a continuous zinc coated surface that may be used as an exterior paint surface and/or for corrosion resistance.

Alternative arrangements of constituent parts and welding may be utilized to produce the required tailored blank. For example, as shown in Figure 5, the constituent part 10a is secured to the constituent part 12a through intersecting lines of welds 40a indicated so that the constituent part 10a is secured about its entire periphery to the constituent part 12.

As shown in Figure 6, the constituent part 10b need not be rectangular or even of regular shape, and the laser beam 36b may be moved along a path conforming to the periphery of the constituent part 10b to secure it to a differently-shaped constituent part 20b.

The above embodiments contemplate the welding of the constituent part at a location spaced from the periphery of the constituent part 10a. However, as indicated at Figure 7, the constituent part 10c may be welded to the constituent part 12c by following the edge of the constituent part and providing a lap weld 40c along the periphery of the constituent part 10c. Again, where the major surface 24c is to be used as a finished surface, the beam 36c is controlled to limit penetration through the constituent part 20c.

The above embodiments show the formation of tailored blanks from generally planar constituent parts. However, as indicated in Figures 8-11, tubular constituent parts 10d,20d may be utilized to provide local reinforcement in the walls of a tubular blank. As seen in Figure 8, the constituent part 10d is tubular and located within tubular component 20d. Laser beam 36d impinges on the radially outwardly-directed major surface 12d and penetrates to the abutting major surfaces 14d,22d to weld the two surfaces together. The tubular constituent part 20d may be rotated about its longitudinal axis relative to the beam 36d to produce a circumferential weld.

The constituent parts 10d,20d may of course be connected at longitudinally spaced locations to connect the constituent parts as required for subsequent forming.

This arrangement is particularly useful where the tubular blank 42d is to be used in a hydroforming operation where high pressure fluid is used to expand a tubular blank 42d into a die cavity. An example is shown in Figure 9 where a radial expansion of the tubular blank

42d produces a bulbous frame component with varying wall thickness. The local reinforcement provided by the part 20d permits varying characteristics to be obtained along the length of the finished component.

As shown in Figure 10, the constituent part 20e may be provided externally of the tube 10e and at a number of longitudinally spaced locations. This facilitates placement of the parts 20e and permits tailoring of the tubular blank 42e. When used in vehicle frames, the variation of wall thickness provided by constituent parts 10e,20e permits a progressive crush resistance to be obtained for the finished component. Similarly, as illustrated in Figure 11, multiple constituent parts may be stacked on top of one another to provide further variation in wall thickness. Of course, a similar stacking may be accomplished with planar components illustrated in Figures 1-7.

The lamination of the tailored blank 42 also enables supplementary materials to be incorporated into the blank 42. As shown in Figure 12, the sound transmission characteristics may be modified by incorporating a non-metal layer 48, such as plastic or paper, between the constituent parts 10g,20g. Typically, the intermediate layer 48 may be 0.004 inches thick and lies within the smaller constituent part 10g to separate the major surfaces 14g;22g and provide a peripheral margin 50 in which contact between the surfaces 14g,22g is not inhibited. The constituent parts may be seam welded around the peripheral margin 50 to inhibit moisture ingress or intermittently welded to retain the layer 48. The resultant tailored blank 42g may then be formed to the required shape in a press with the intermediate layer 48 retained in situ during forming.

A further example of a component formed from a tailored blank is shown in Figures 13-16 where the formation of a shock tower for use in a vehicle body is shown using the process steps shown in Figure 17. A shock tower is used to support suspension components in a vehicle and as such is subjected to severe local shear loadings. However, the shock tower is usually elongated to accommodate the vertical displacement of suspension components and therefore has a significant wall area.

A blank 42h is formed from a constituent part 20h and a pair of first constituent parts 10h. The second constituent part 20h is formed from a planar sheet of cold rolled steel with a pair of D-shaped cutouts 52 located in local depressions 53. The cutouts 52 and depressions 53 are provided in a preforming step by stamping a sheet of material in a conventional

manner.

The first constituent parts 10h are cut from sheet stock which is thicker and of higher strength to serve as a mounting point and located over the cutouts 52. The parts 10h overlap the edges of the cutouts 52 within the depression to provide a peripheral margin 54 of juxtaposed parts. The depth of the depressions corresponds to the thickness of the parts 10h so that the major surfaces 24h and 14h are coplanar. A flat surface is thus provided to facilitate subsequent forming operations.

The constituent parts 10h,20h are then laser welded to one another in the margin 54 with a continuous weld 40h as indicated above.

The resultant blank 42h contains two individual blanks for forming the shock towers and so is separated along a line of symmetry 56 into individual blanks. Each individual blank is then formed in a press into a shock tower as shown in Figure 16 with walls of relatively thin material but with mounting plates provided with a double thickness by the constituent parts 10h.

The techniques described above may also be utilized to provide a blank incorporating non-weldable components, or components that are not compatible for welding to one another. For example, mild steel and aluminum are each weldable but when welded to one another brittle, intermetallic compounds are formed.

One such arrangement is shown in Figures 18-20 in which a pair of constituent parts 10j,20j are interconnected by welds 40j and are mechanically connected to an additional component 60. The component 60 is a plastics material and has a series of rectangular depressions 62 along marginal edges 64. An undercut 66 is formed on the edge of constituent part 10j with an undersurface 68 spaced from the major surface 24j by the thickness of the additional component 60. Projections 70 depend from the undersurface 68 and are complementary to the depressions 62 so as to be a snug fit within them.

The constituent parts 10j,20j are positioned in juxtaposition with the component 60 located between. The projections 70 engage the depressions 62 so that the component 60 is mechanically locked to the part 10j. The parts 10j,20j are then welded at 40j to connect them and secure the component 60. The resultant blank may then be formed with the mechanical connection retaining the integrity of the parts 10j and component 60. It will be appreciated that the component 60 may be a plastics composite, glass or other material not normally

weldable or could be a dissimilar metal material such as aluminum.

As an alternative to the rectangular depressions 62, part-spherical recesses may be used as shown in Figure 21. In this embodiment, recesses or "dimples" 72 are formed in each of the parts 10k,20k and component 60k by a part-spherical punch and the parts 10k,20k welded to one another to form an integral blank 42k.

The mechanical interconnection of the component 60 and parts 10,20 may be utilized in a number of ways as shown in Figure 22. The component 60 may be used to cover an aperture in the part 20 as shown in Figure 22a, or may form a lining over a portion of the part 20 as shown in Figure 22b.

The component 60 may be circular as illustrated in Figure 22c or may be formed with a peripheral rabett so that a flush surface is provided as shown in Figure 22d.

In some circumstances, a positive mechanical connection is not necessary in which case a frictional location is obtained by deflection of one or both constituent parts as shown in Figures 22e-22h. In such arrangements, the component 60 is mechanically trapped by the constituent parts to permit subsequent forming operations.

It will be seen that the preparation of a tailored blank with constituent parts juxtaposed permits the blank to be formed with different material characteristics without the need for precision edge preparation of the parts.

Other typical applications in which the above embodiments find utility are the provision of a strengthening section in a door skin of a vehicle to receive a door lock assembly or mounting pads for attachment of seat belts on a floor pan of a vehicle.

Although laser welding is preferred, alternative welding techniques may be used such as MASH welding that permits the blank to be assembled and subsequently formed. The welding pattern will be selected to meet the structural requirements of the forming process, including the drawing properties of the blank and the components' subsequent use.

By securing the constituent parts into a blank prior to forming, the need for accurately fitting the parts for seam welding into a unitary blank is mitigated. Moreover, because the required material characteristics can be obtained from the blank, the need to weld additional components after the forming process is avoided. This is particularly significant as the accurate fitting of complex shapes after forming is difficult and time-consuming. A uniform closed surface may also be obtained without relying upon the integrity of the weld.

In each of the above embodiments, a continuous weld has been illustrated between the constituent parts. Where structural requirements permit, it is of course possible to provide localized welding at discrete locations over the constituent parts so that the constituent parts are held together during forming but a continuous weld is not necessary.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A tailored blank for subsequent forming into a finished component, said bank having a pair of metal constituent parts, each having a pair of oppositely directed major surfaces with a major surface of one component juxtaposed with a major surface of another component, said constituent parts being welded to one another to provide a unitary blank.

2. A tailored blank according to claim 1 wherein another major surface of one of said constituent parts provides a continuous outwardly directed surface to said blank.

3. A tailored blank according to claim 1 or 2 wherein said constituent parts are laser welded to one another.

4. A tailored blank according to claim 3 wherein said laser weld terminates prior to another of said major surfaces of one of said constituent parts.

5. A tailored blank according to any one of claims 1-4 wherein said constituent parts are welded to one another at spaced locations.

6. A tailored blank according to any preceding claim wherein one of said constituent parts is preformed to receive the other of said constituent parts.

7. A tailored blank according to claim 6 wherein an aperture is provided in said preforming and said other constituent part overlies said aperture.

8. A tailored blank according to claim 1 wherein said constituent parts are each planar.

9. A tailored blank according to claim 8 wherein said constituent parts are each tubular.

10. A tailored blank according to claim 1 wherein an intermediate layer is interposed

between said major surfaces of said constituent parts.

11. A tailored blank according to claim 10 wherein said intermediate layer is a non-metal.

12. A tailored blank according to any preceding claim wherein one of said constituent parts lies within the periphery of another of said constituent parts.

13. A tailored blank according to any preceding claim wherein an additional component is mechanically connected to one of said constituent parts.

14. A method of forming a finished component from constituent parts of a metal blank, said method comprising the steps of juxtaposing oppositely directed major surfaces of said constituent parts, welding said constituent parts to one another to provide a tailored blank having varying physical characteristics and subsequently forming said tailored blank to provide a finished shaped component.

15. A method according to claim 14 wherein said constituent parts are welded to one another at spaced locations.

16. A method according to claim 15 wherein one of said constituent parts lies wholly within the periphery of another.

17. A method according to claim 14 including the step of preforming one of said constituent parts prior to juxtapositioning said constituent parts.

18. A method according to claim 17 wherein said step of preforming includes forming an aperture in one of said constituent parts.

19. A method according to claim 18 wherein another of said constituent parts is positioned to overlie said aperture prior to welding.

20. A method according to claim 17 wherein said step of preforming includes providing a localized depression in said one of said constituent parts, said depression receiving the other of said constituent parts.

21. A method according to claim 20 wherein a major surface of said other constituent part is coplanar with a major surface of said one constituent part.

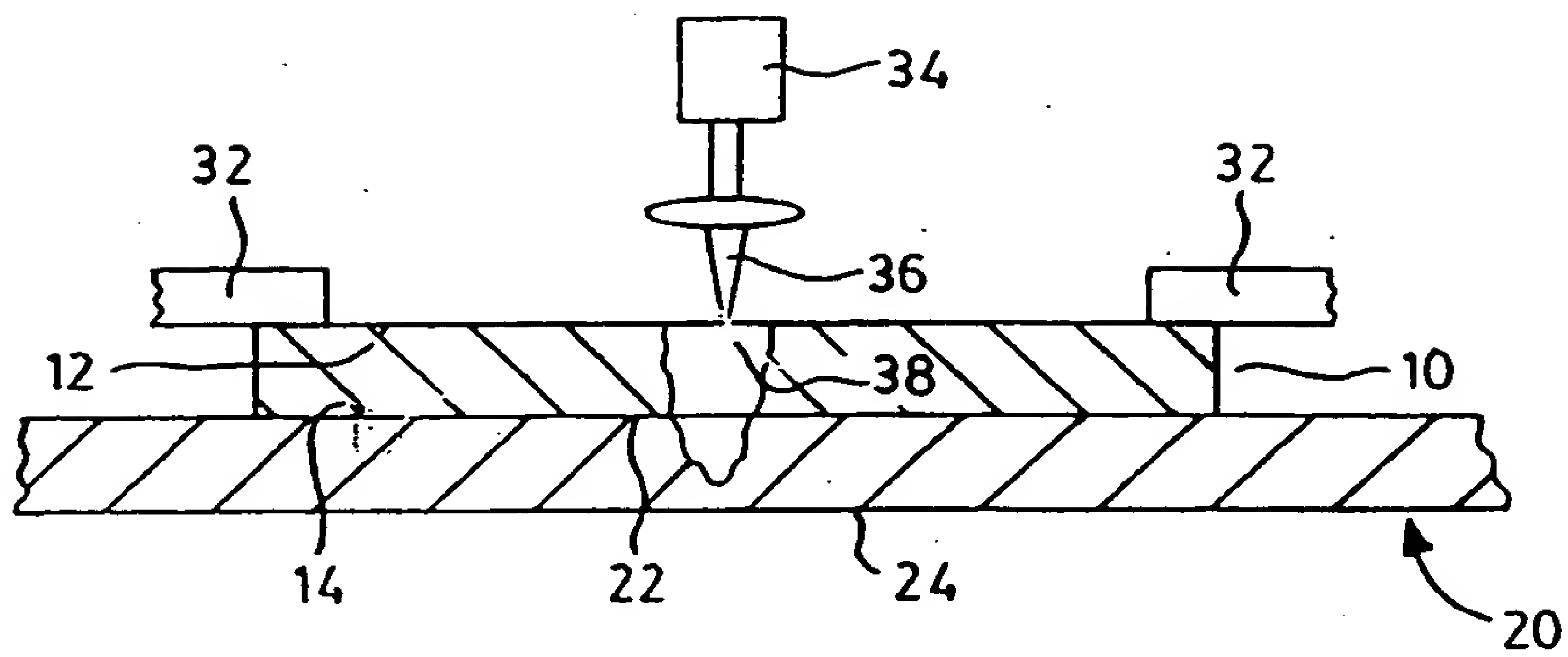

FIG. 1

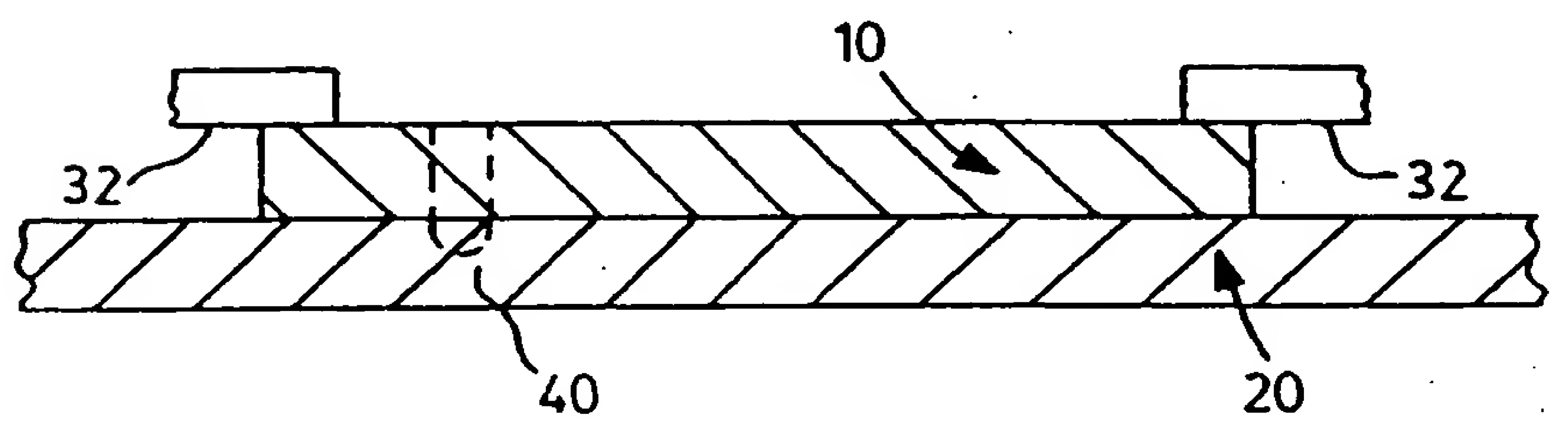

FIG. 2

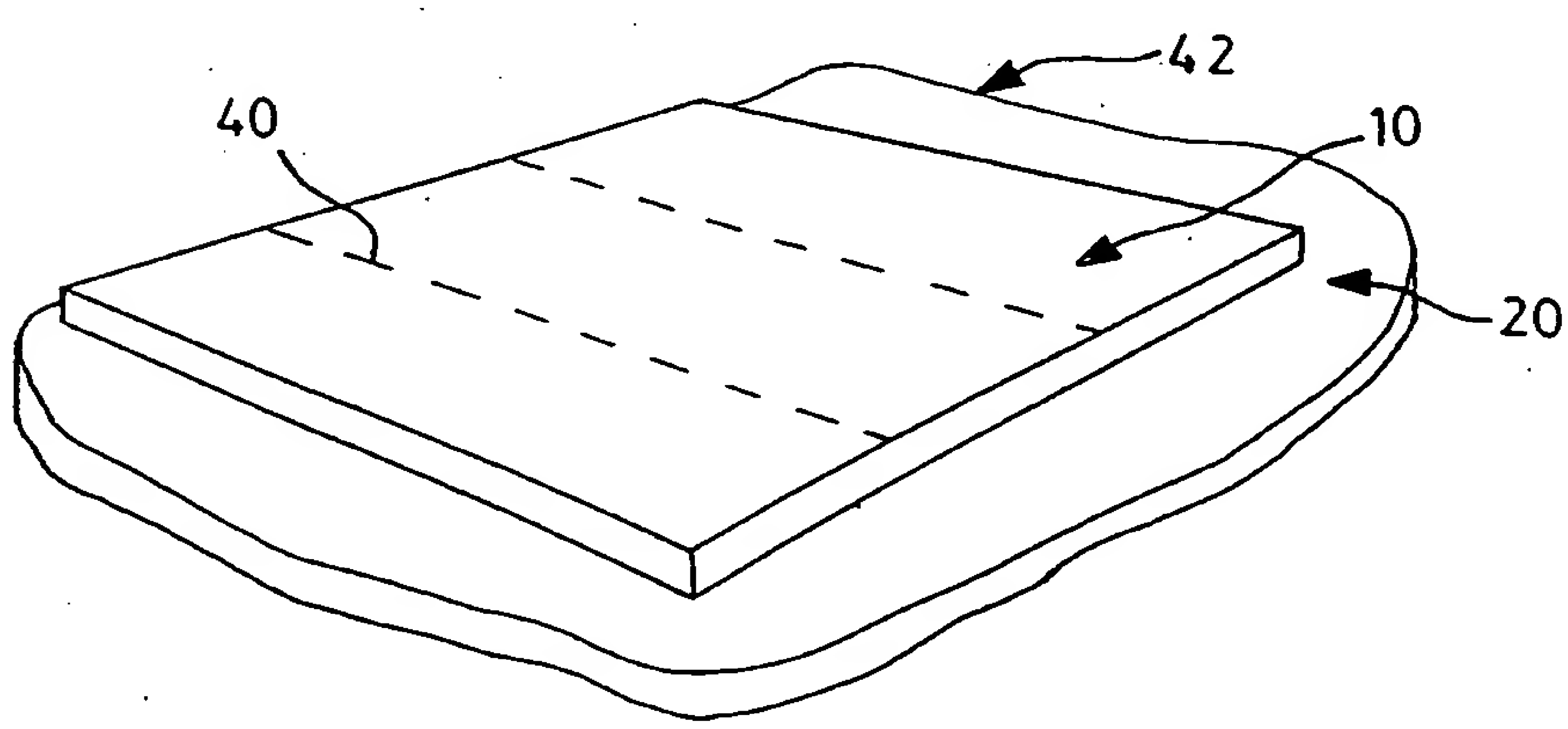

FIG. 3

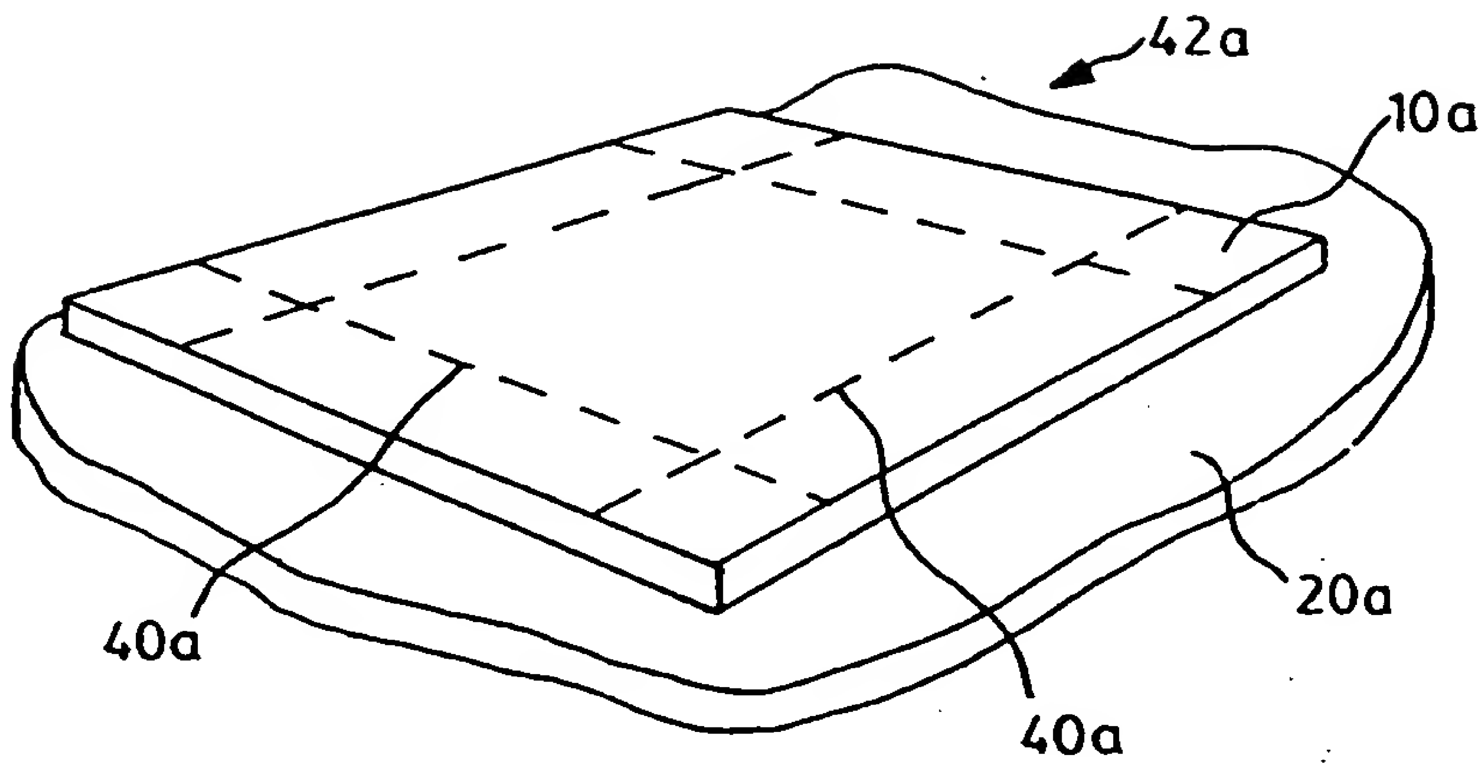

FIG. 5

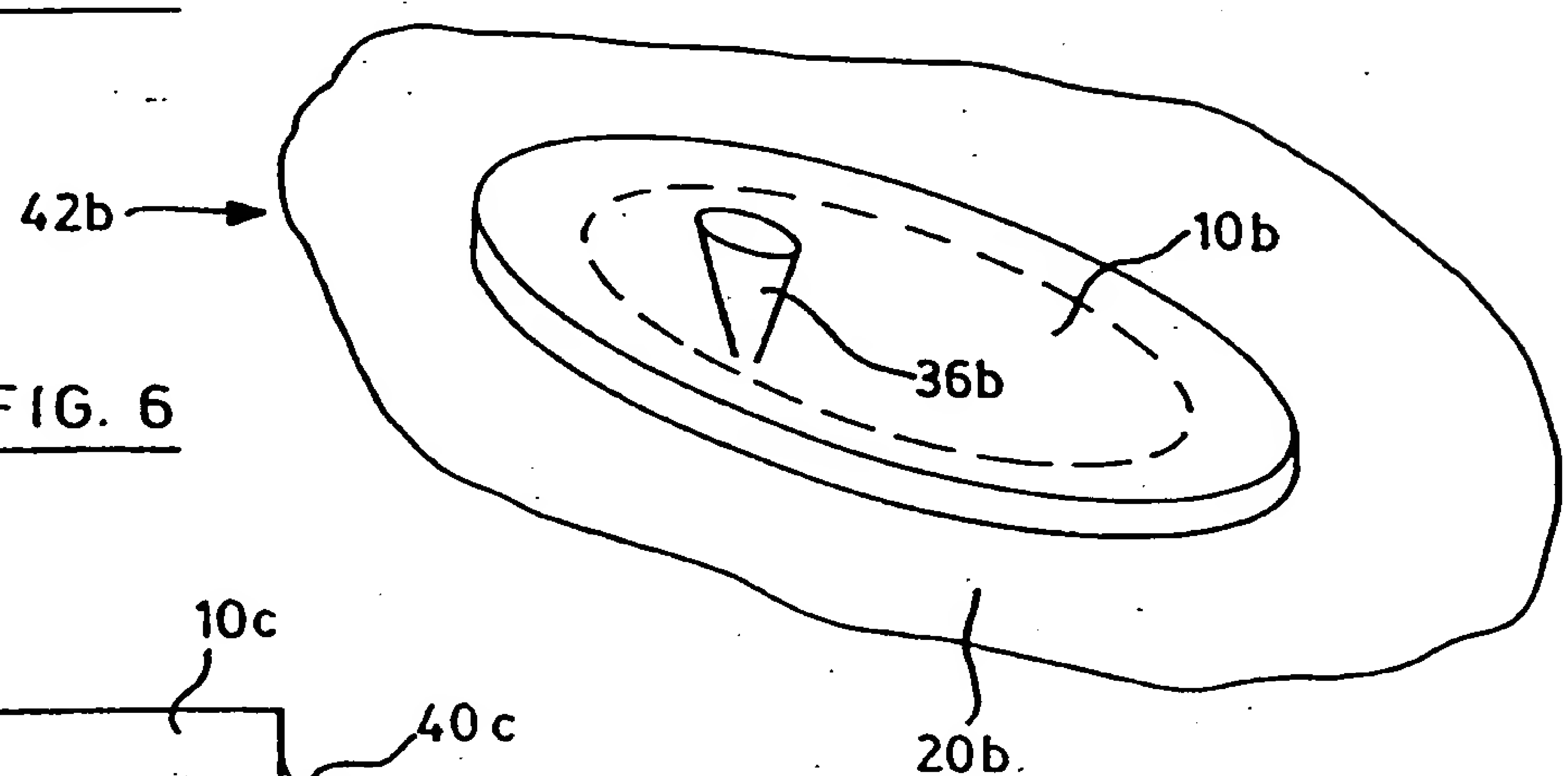

FIG. 6

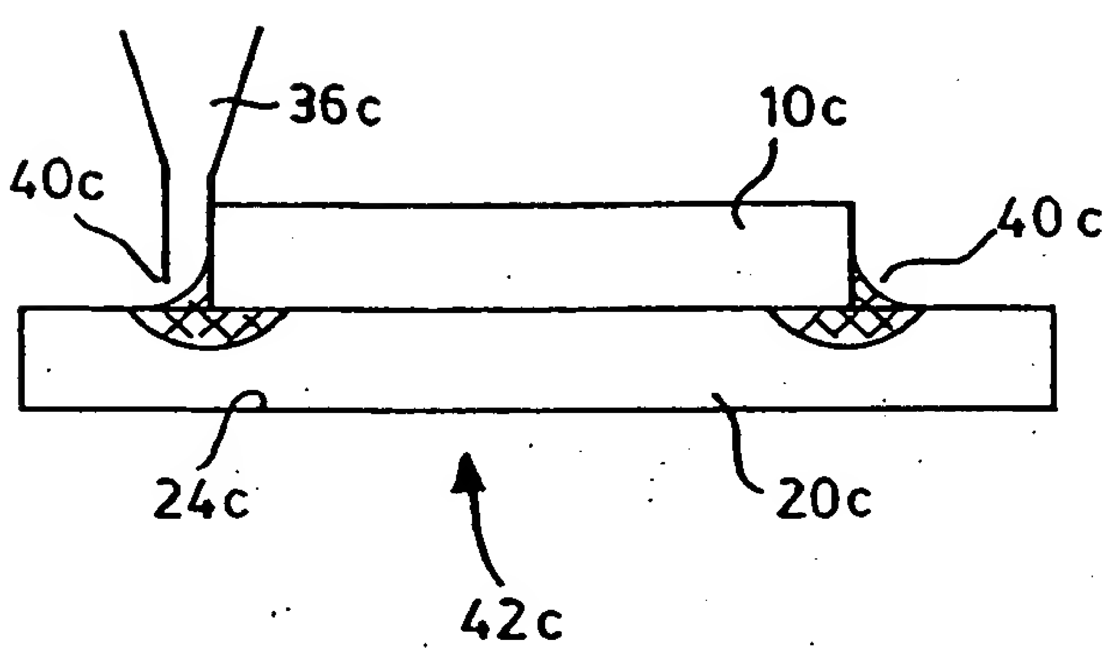

FIG. 7

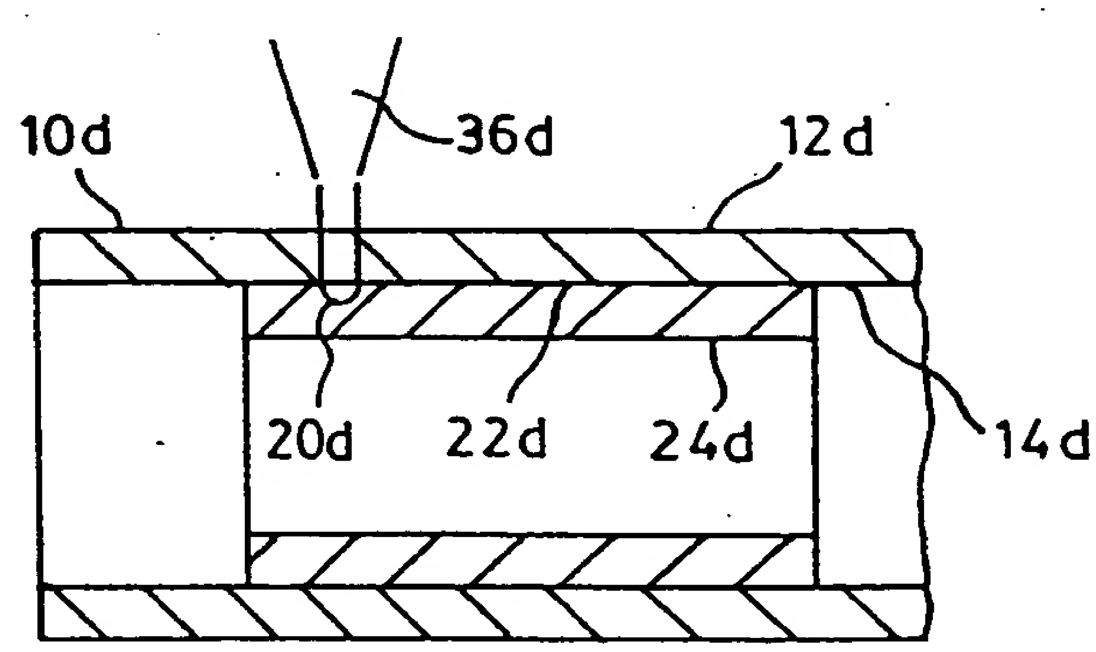

FIG. 8

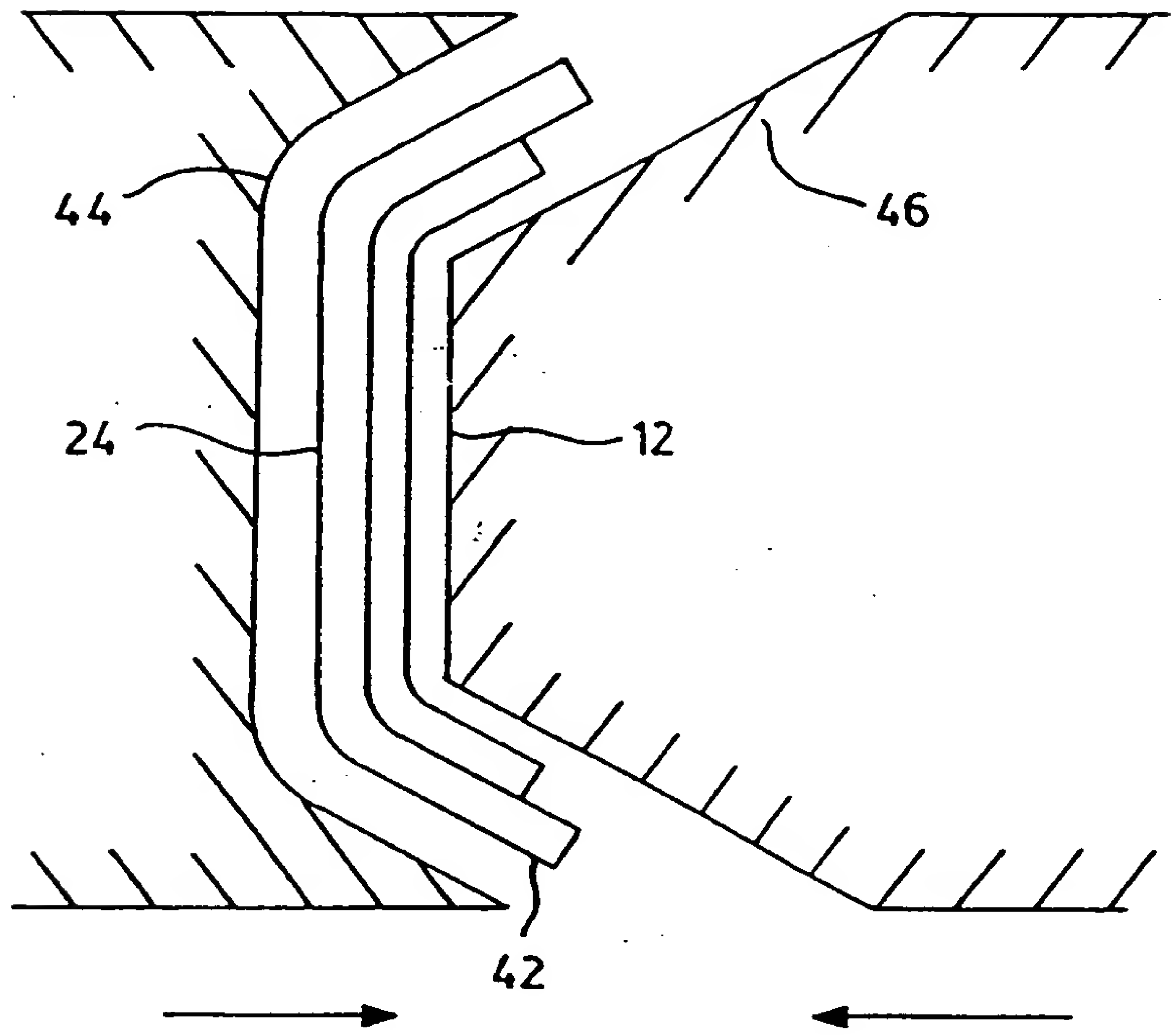

FIG. 4

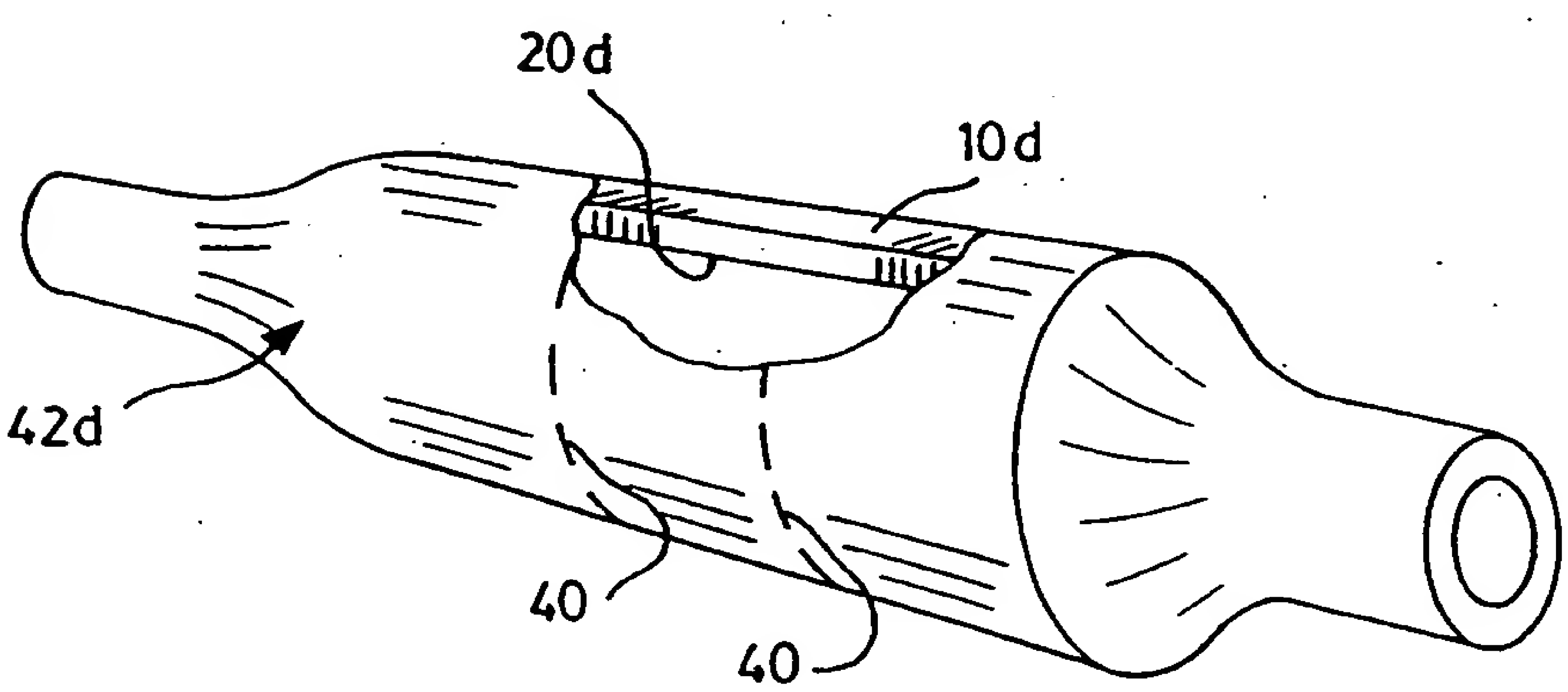

FIG. 9

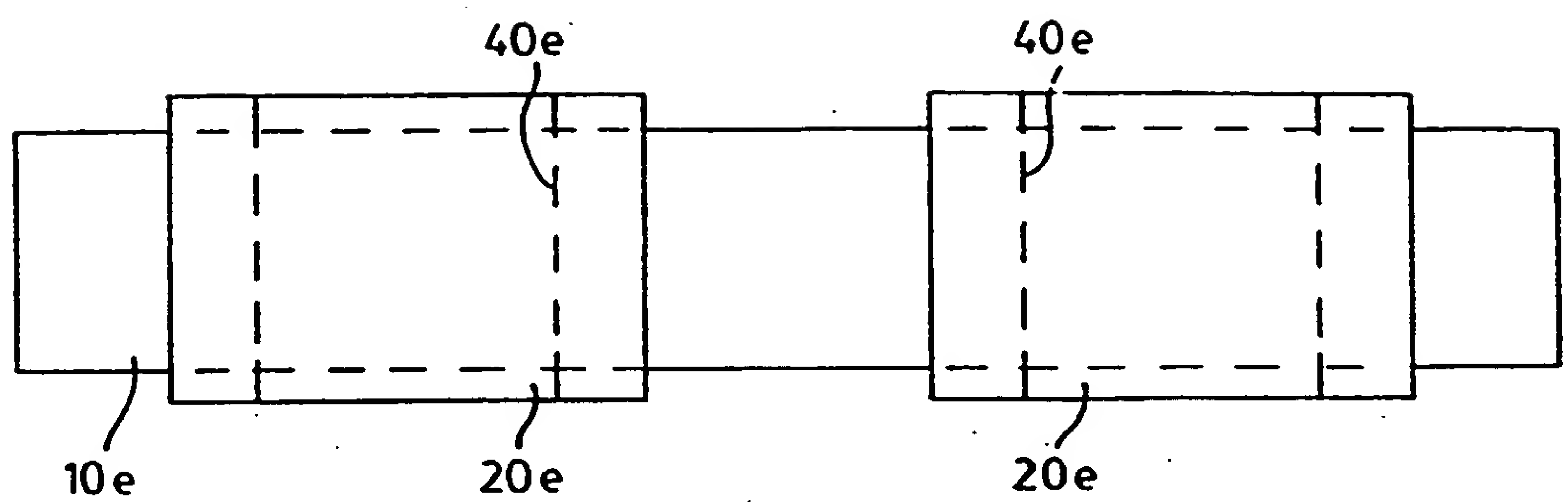

FIG. 10

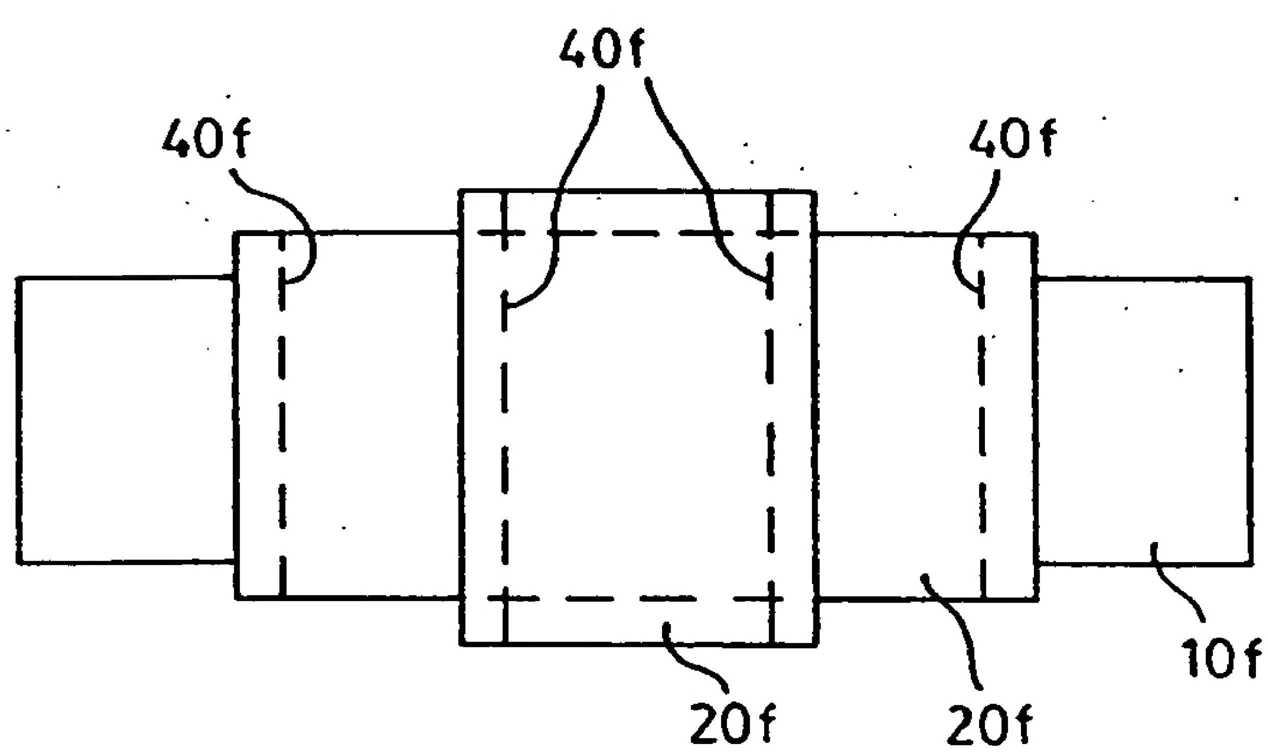

FIG. 11

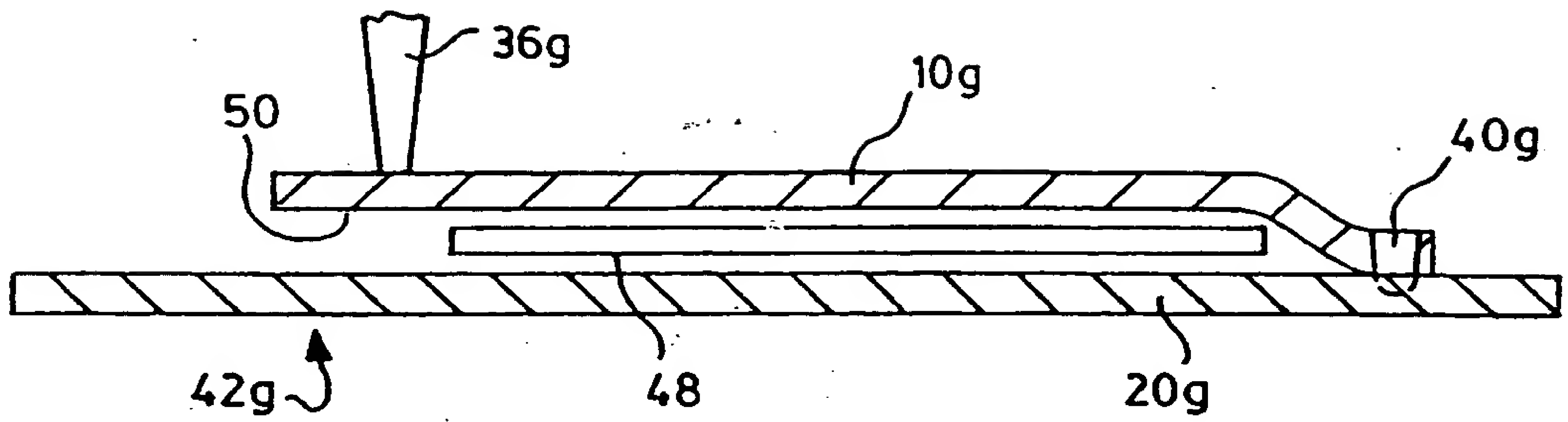

FIG. 12

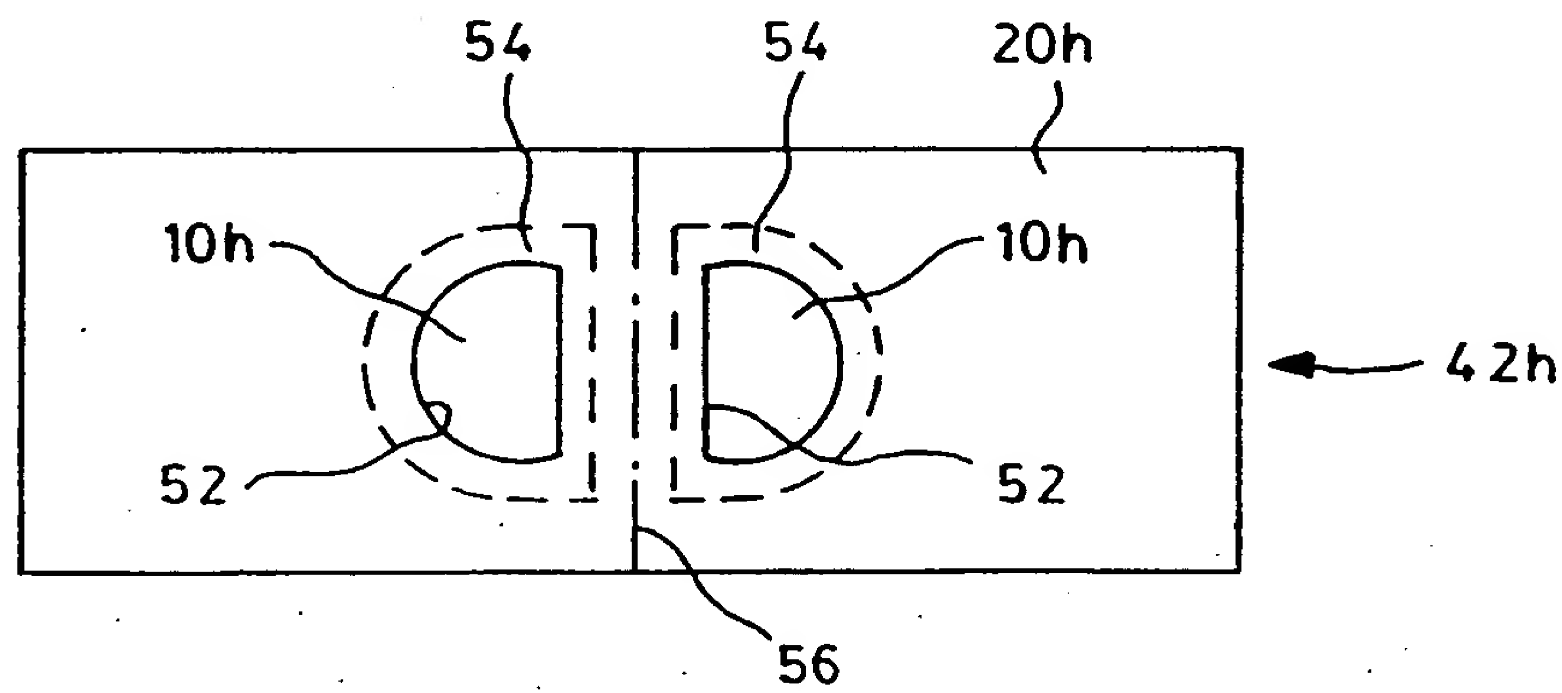

FIG. 13

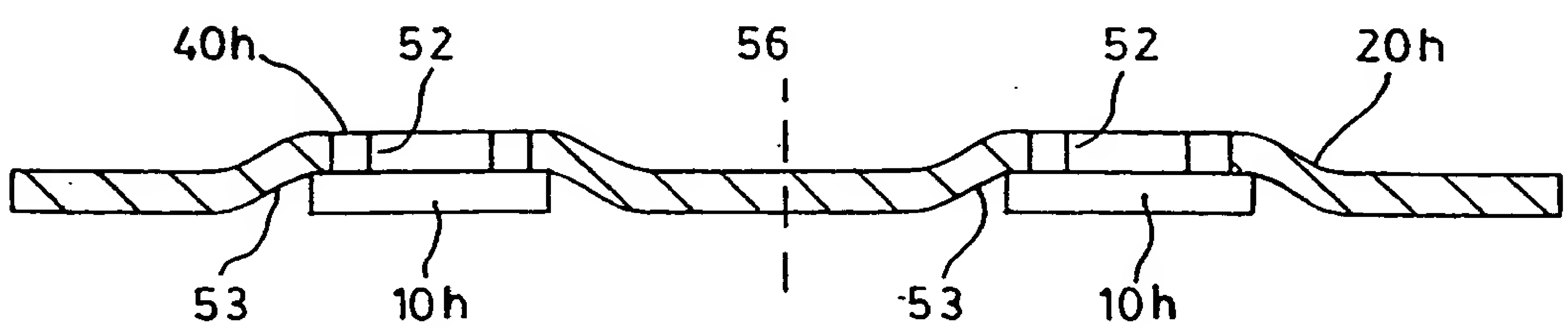

FIG. 14

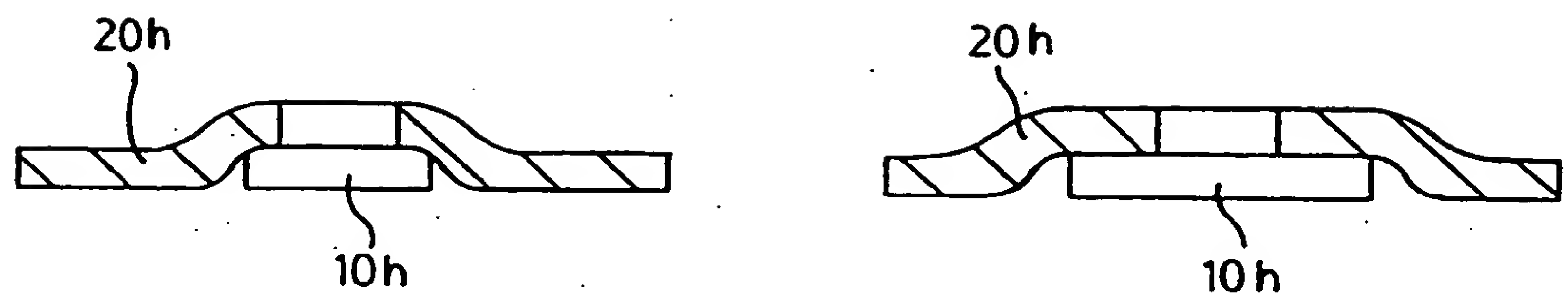

FIG. 15

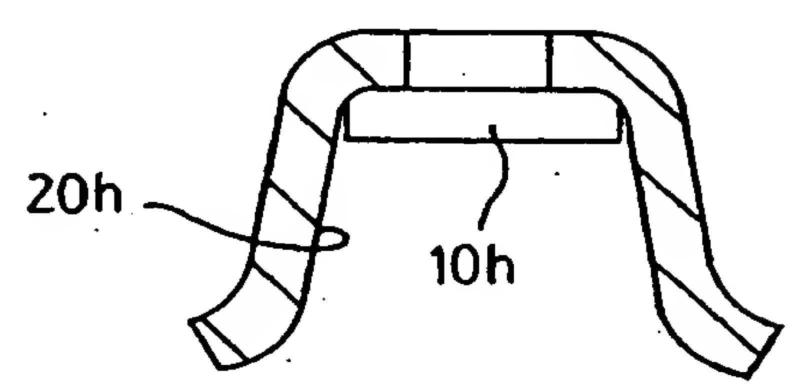

FIG. 16

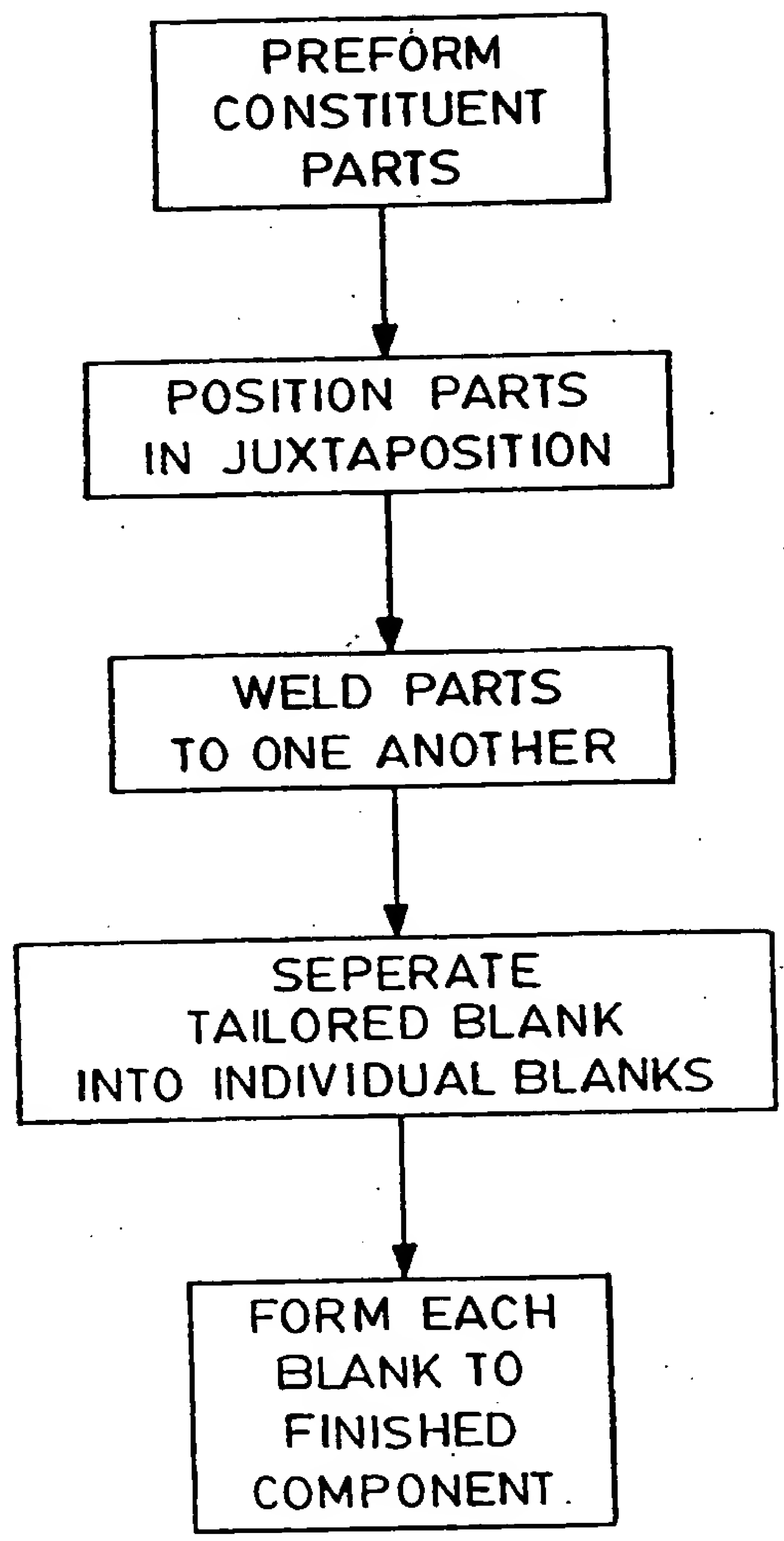
PREFORM CONSTITUENT PARTS
POSITION PARTS IN JUXTAPOSITION
WELD PARTS TO ONE ANOTHER
SEPERATE TAILORED BLANK INTO INDIVIDUAL BLANKS
FORM EACH BLANK TO FINISHED COMPONENT.

FIG. 17.

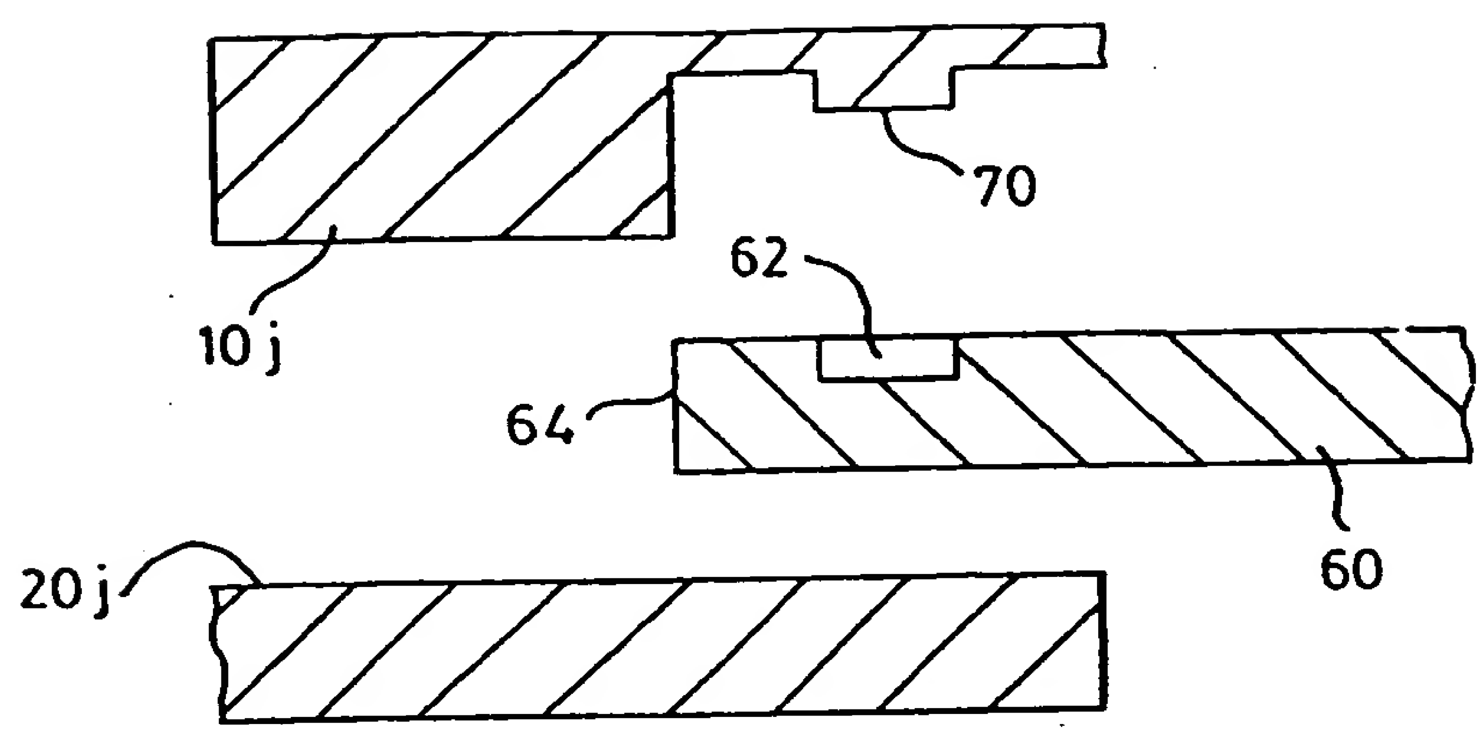

FIG. 18

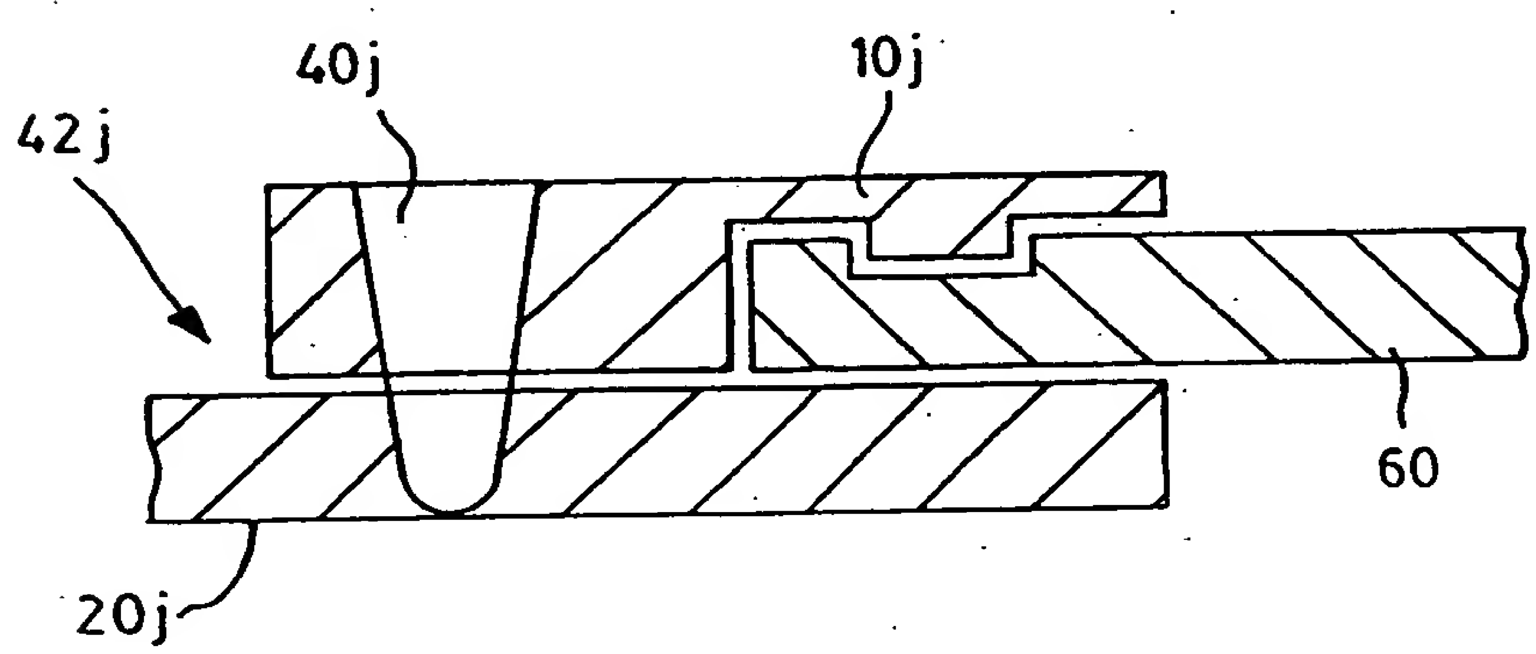

FIG. 19

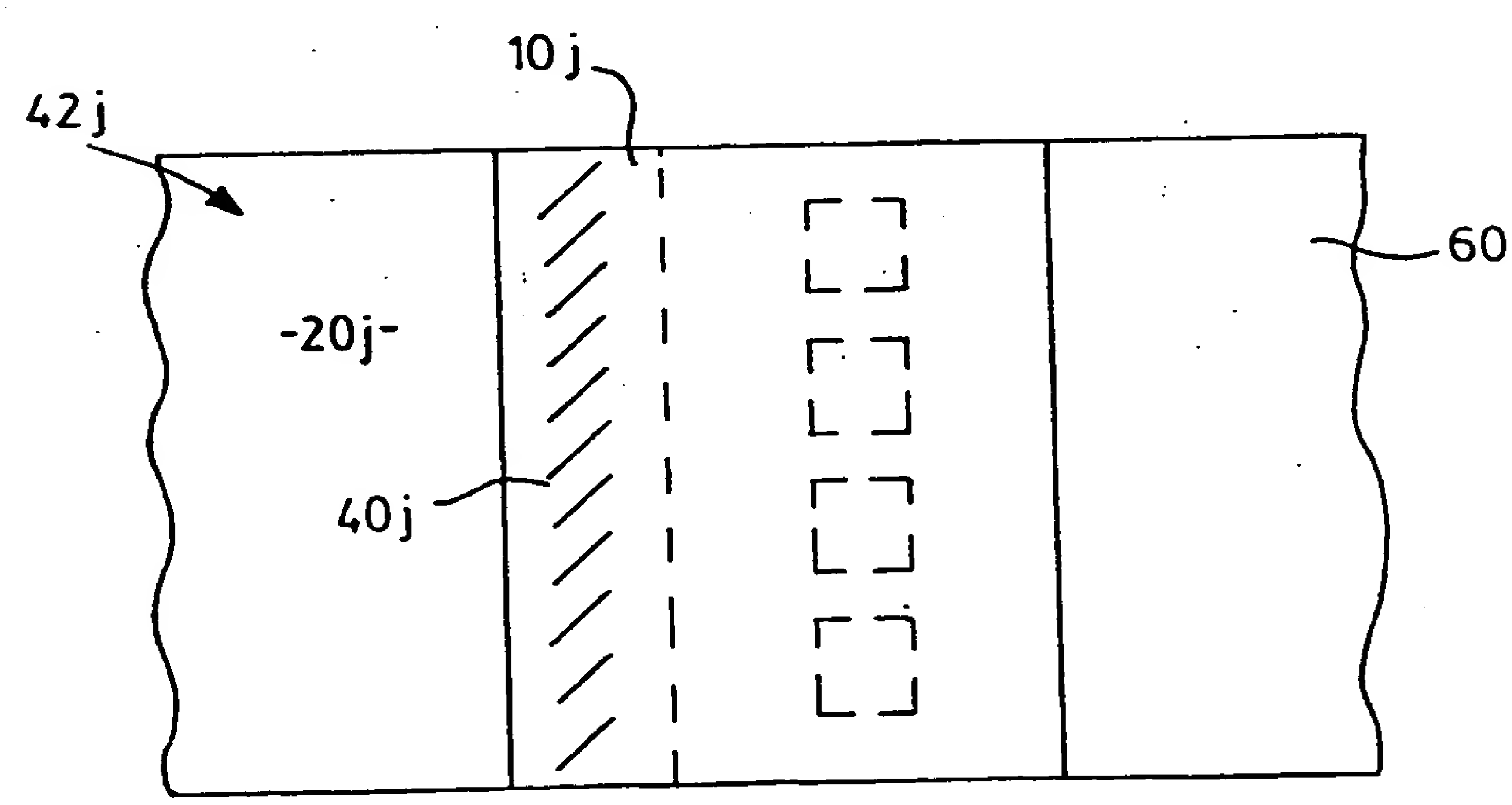

FIG. 20

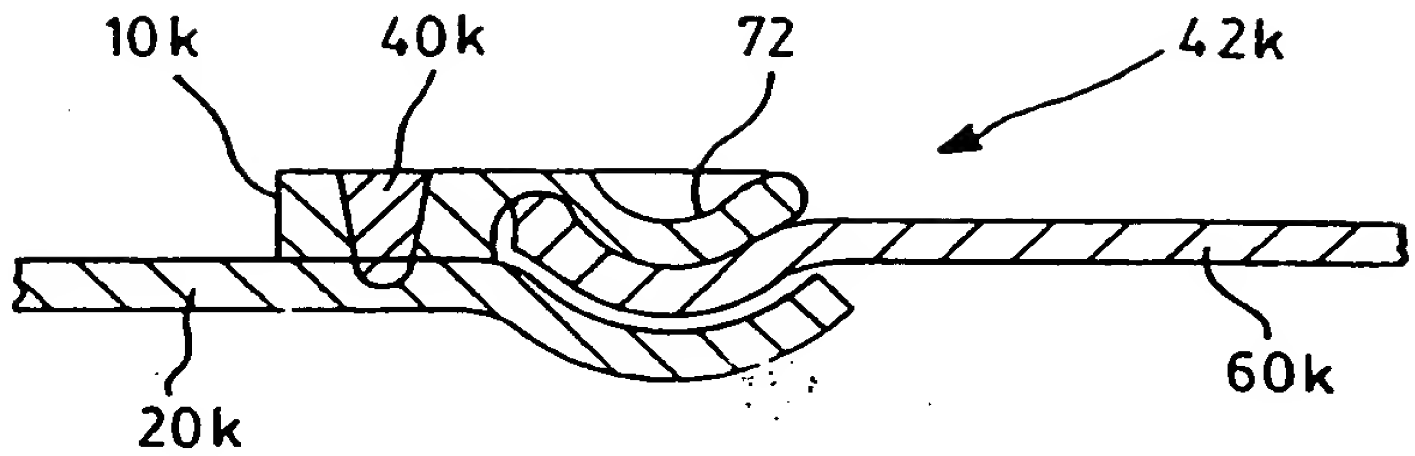

FIG. 21

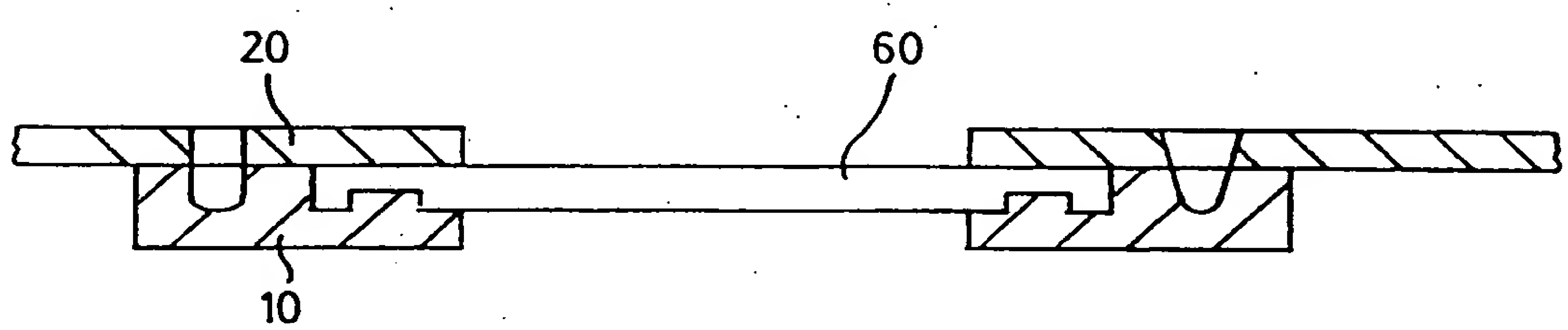

FIG. 22a

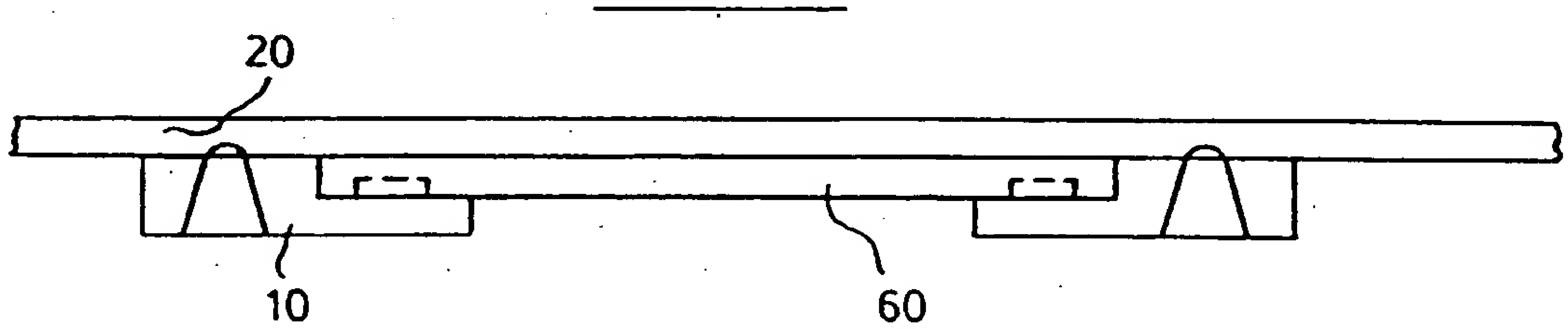

FIG. 22b

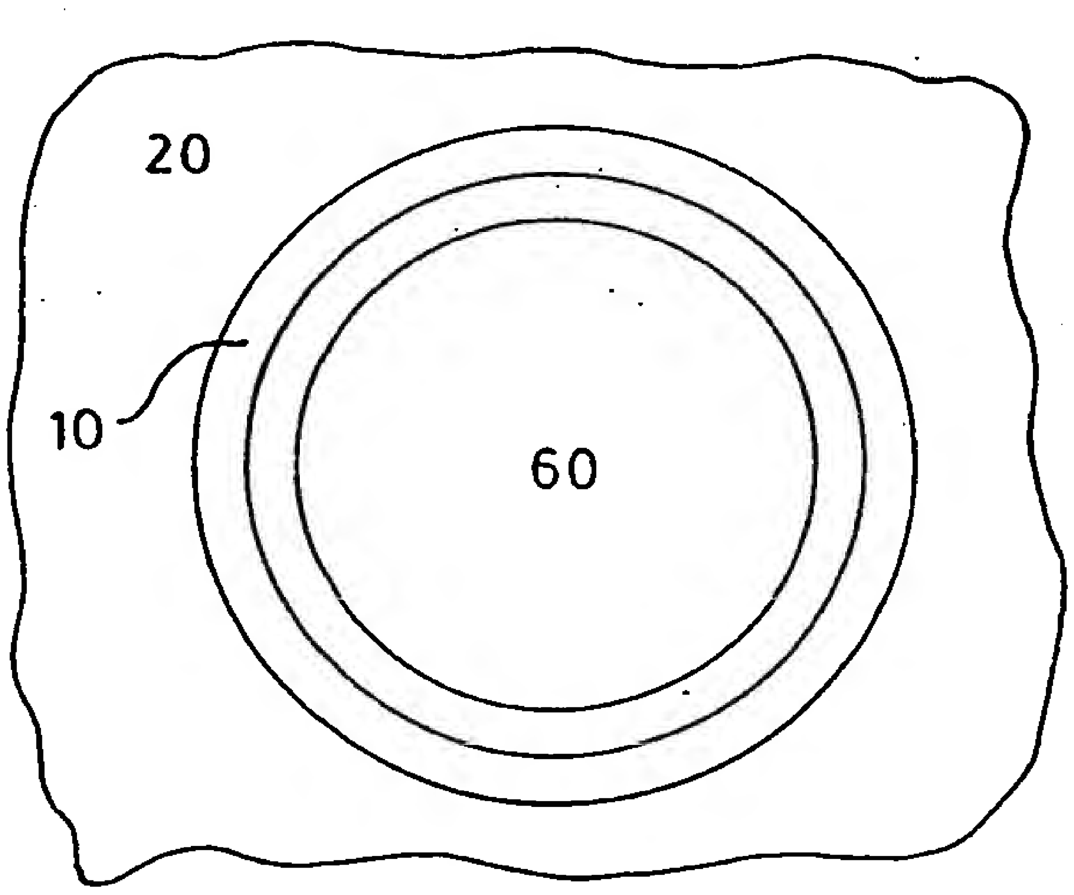

FIG. 22c

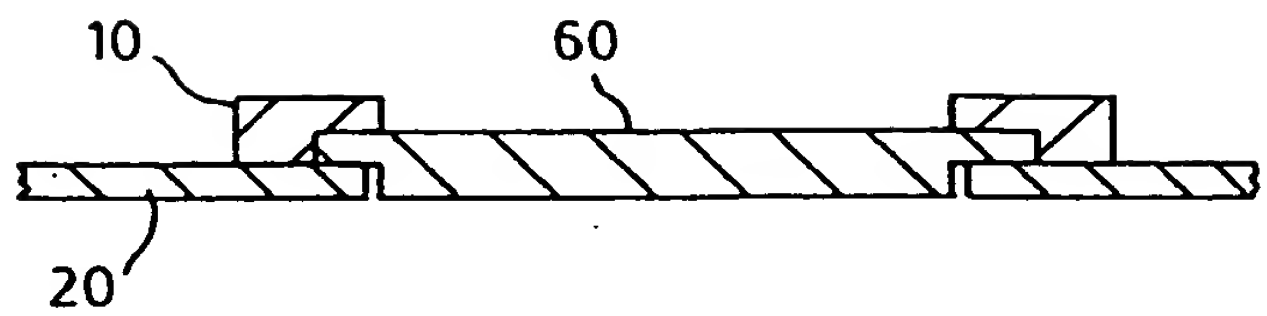

FIG. 22d

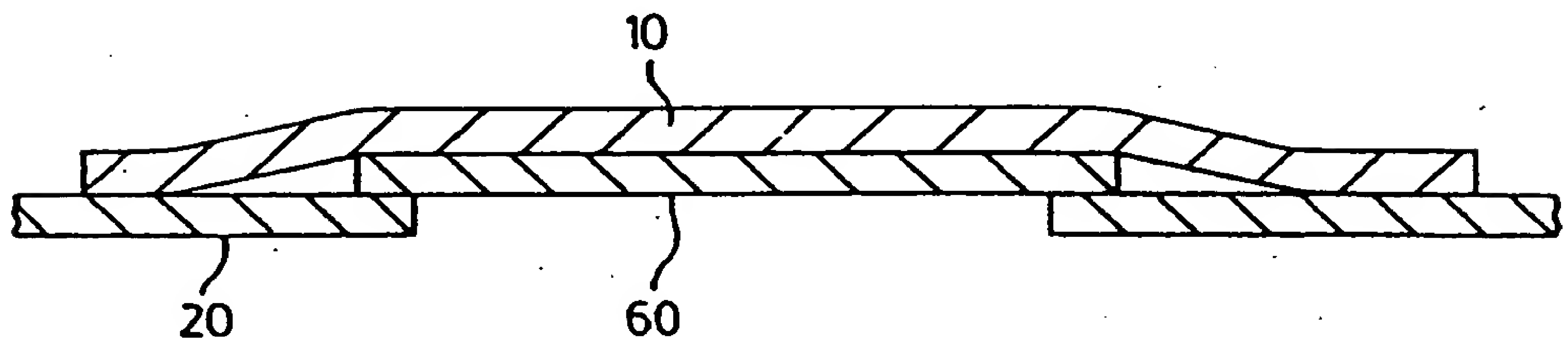

FIG. 22e

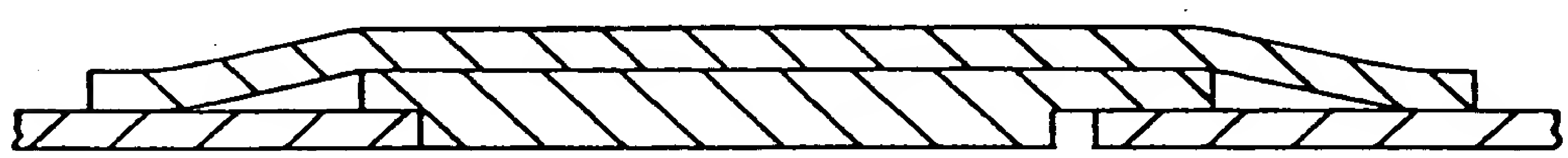

FIG. 22f

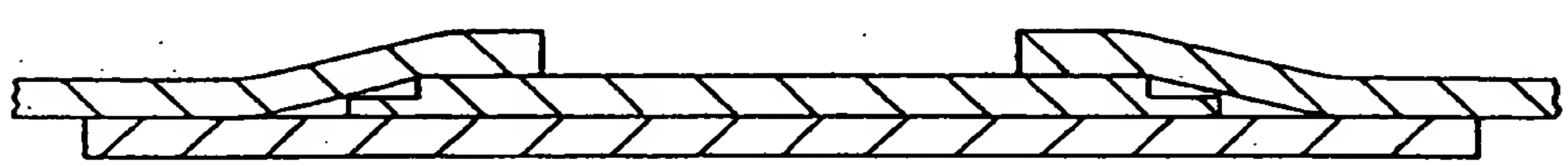

FIG. 22g

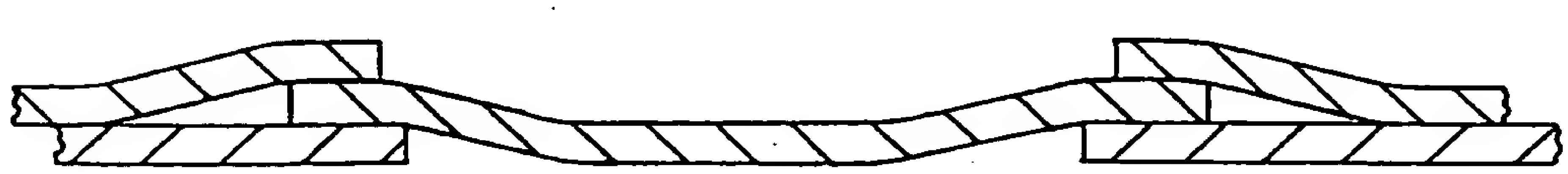

FIG. 22h

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 97/00854

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B21D39/03 B23K26/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B21D B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 43 07 563 A (BAYERISCHE MOTOREN WERKE AG) 23 September 1993 see column 2, line 23 - column 2, line 48; figures 1-3 ---	1-3,5,6, 8,10-17
X	EP 0 327 320 A (RAYCON CORPORATION) 9 August 1989 see column 3, line 40 - column 4, line 57; figures 2-7 ---	1-3,5,6, 8,10-17
X	DE 42 10 547 A (HAMPEL, HEINRICH, DR.) 3 June 1993 see column 1, line 60 - column 3, line 67; figure 3 ---	1-5,9-16
X	US 4 661 677 A (FIAT AUTO S.P.A.) 28 April 1987 see the whole document --- -/--	1-6,8, 12,14-17

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

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Date of the actual completion of the international search	Date of mailing of the international search report
26 March 1998	24.04.98

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Vinci, V

International Application No
PCT/CA 97/00854

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 8, no. 203 (M-326), 18 September 1984 & JP 59 092189 A (TOSHIBA KK), 28 May 1984, see abstract	1-6,12, 14-17

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inten   ıal Application No
PCT/CA 97/00854

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4307563 A	23-09-93	NONE	
EP 327320 A	09-08-89	US 4873415 A	10-10-89
DE 4210547 A	03-06-93	WO 9320382 A	14-10-93
US 4661677 A	28-04-87	BR 8504087 A	17-06-86
		EP 0173655 A	05-03-86
		JP 1892493 C	26-12-94
		JP 6015113 B	02-03-94
		JP 61063390 A	01-04-86